ENDOCRINE SYSTEM

Progestational hormone
↓
progesterone

Neural system → point-to-point
Rapid Co-ord.
Fast
Short lived

Nerve fibre do not innervate all the cells of body & the cellular function need to be regulated → Thus came Endocrine System
↓ carried by
Hormones.

jointly co-ord. & regulate physiological func. in body

Endocrine Glands → Lack ducts → ductless glands.
/system
↓
secrete → hormones → Released into blood & transported to distantly located target organs

hormones:
- non nutrient chem.
- intercell. messengers
- In trace amounts.

this def. covers:
- New molecules
- Hormones secreted by organised Endocrine gland.

Simple → Few hormones → Invertebrates
Complex → Many hormones → Vertebrates

Human Endocrine System →

Endocrine glands
↓
Organised
↓
Pituitary
Pineal
thyroid
adrenal
pancreas
parathyroid
thymus
Gonads

Hypothalamus not written here in NCERT mentioned seperately as "of all major endocrine glands & hypoth."

hormone producing diffused tissue/ cells located in diff parts of body

* In addition to these → some other organs
1. Gastrointest. tract
2. Liver, Kidney
3. heart

→ hormones

HYPOTHALAMUS

↓

Basal part of diencephalon (forebrain)

↓

Regulates wide spectrum of body funct.

↓

Contains several groups of neurosecret. cells → "nuclei" → hormones

Regulate the synthesis & secretion of pituitary hormones

Releasing hormone
↓
Stimulate pit. secretion
↓
GnRH → stimulate gonadotrop. release from pit.

Inhibiting hormone.
Inhibition of pit. secretion
↓
Somatostatin → inhibits the growth hormone release from pit.

Ant. pituitary → Hormones reach through portal circulatory system → regulate the function of.

Post. pituitary → Under direct neural reg. of hypothalamus.

PITUITARY GLAND → regulate growth & activities develop. of somatic tissues & activities of peripheral endocrine glands.

↓

Located in bony cavity → sella turcica (attached to hypoth. by a stalk.)

anatomically divided.

Adenohypophysis

produce simple hormones

Pars distalis (Ant. pituitary)
↓
GH
PRL
TSH
ACTH
LH
FSH

Pars intermedia
↓
MSH (Melanocyte stimulating hormone)
- Acts on melanocyte
- Regulate pigmentation of skin

*However pars intermedia is almost merged with pars distalis, in HUMANS

Neurohypophysis (posterior pituitary) pars nervosa

↓

"STORES" & "RELEASES"

→ Oxytocin
→ Vasopressin

→ "synthesized" in hypothalamus & transported axonally to post. pitutary.

GH

Over
↓
Gigantism
- abnormal growth
- In child age (over secret. hota.)

Deficient
Pit. dwarfism
- stunted growth
- In child age (deficient hota)

Over secretion of GH in adults: Acromegaly
- In adult or middle age especially
- Severe disfigurement (of face)
- Serious complications
- Premature death if unchecked.
- Hard to diagnose in early stage
- Goes undetected for many years
- Changes in ext. feat. become noticeable

Prolactin

Regulates growth of mammary glands
↓
Formation of milk

Gonadotroph. (stimulate gonadal activity)

LH

Males
↓
Stimul. "synth" & "secr" of horm. called androgens from testis.

Female
↓
Induce ovulation of fully mature graafian follicle & maintains C.L.
Remnants of graaf. follicle

FSH

Males
Along with androgen + FSH it regulations spermatogenesis.

Female
stimulate growth of & develope of ovarian follicles in female.

TSH → Stimulates the "synth." & "secr." of thyroid hormones from its gland.

ACTH → Stimulates the "synth" & "secr" of steroid hormone (glucocorticoids) from adrenal cortex.

ytocin → Acts on smooth muscle → cause contraction
Pitocin → In Females → stimulates a vig. contr. of uterus at child birth
→ Milk ejection from mammary gland.

Vasopressin → Acts on kidney → Stimulates reabsorption of water & electrolytes by distal tubules & thereby reduce loss of water through urine (diuresis).
↳ ADH

* Impairment affecting synth. or release of ADH → water loss & dehydr. → Diabetes insipidus.

THE PINEAL GLAND

Location — Dorsal side of forebrane.
Secretions — melatonin

Functions
- Regulation of 24 hr diurnal rythm of body
- Maintaining normal rythm of sleep-wake cycle.
- body temp.
- Metabolism
- Pigmentation
- Defense capability

THE THYROID GLAND

* Iodine is essential for normal rate of hormone synthesis in thyroid.

Location : Two lobes on either side trachea
- connected by a thin flap of connective tissue "Isthmus".

Secretes a protein hormone TCT.
- which regulate blood calcium level (decrease Ca^{2+})
- Calcium homeostasis

Follicles
- Follicular cells enclosing a cavity.
  - T_4 (Tetraiodothyronine or Thyroxine)
  - T_3 (Triiodothyronine)

Stromal tissues.
- Thyroiderin
  - Hypo
    - Goitre (enlargm. of thyroid gland)
      - During pregnancy
        - Defect. dev. & matur. of growing baby
          - Stunted growth (cretenism)
          - Mental retardation
          - low intelligence quotient.
          - abnormal skin
          - deaf-mutism
      - In adult women, irregular menstrual cycle
  - Hyper
    - Due to cancer of thyroid gland & due to development of nodules of thyroid glands the rate of "synth" & "sect" bec omes abnormally high
      - Exophthalmic goitre
        - Enlargement of thyroid gland
        - Protusion of eye ball
        - Increased basal metabolic rate
        - Weight loss
        - "Grave's disease"

* Thyroid hormone :
- → Regulates basal metabolic rate.
- → Support erethropoesis
- → Controls metabolism of protein carbohydrates & fats.
- → Maintenance of water & electrolyte balance.
- → Maturation of central nervous system

PARATHYROID GLAND

Four glands present"

Location : Back side of thyroid gland
One pair each in two lobes of thyroid gland

Secretes : PTH → peptide hormone

↓

Its secretion is regulated by circulating levels of calcium ions.

Function :

→ PTH, ↑ the Ca^{2+} in blood.

→ PTH, acts on bones & stimulates bone resorption (dissolution/demineralisation)

→ PTH, stimulates reabsorption of Ca^{2+} by renal tubule & ↑ Ca^{2+} absorption from digested food.

→ Hypercalcemic

Along with TCT, balances calcium levels in body

THYMUS

"Lobular structure"

~~Function~~ Location : b/w lungs
behind sternum
On ventral side of aorta

Function : Develop. of immune system.

Secretes : Thymosins → peptide hormone

↳ helps in differentiation of T-lymphocytes

↓

provide cell mediated immunity.

* Thymosins also promote prodi. of antibodies hence to provide humoral immunity.

* Thymus → degenerated → Old individuals

↓

Decreased production of thymosin

↙

Immune responses of old person become weak.

ADRENAL GLAND

(One pair)
(anterior part of each kidney)

corticoids
↑
secrete many hormones

Centrally located (Adrenal Medulla)

Catecholamine

- Adrenaline / epinephrine
- Noradrenaline / norepinephrine

Rapidly secreted in response to stress of any kind & during emergency situation

"emergency hormones"
"Hormones of fight or flight"

These hormones

- alertness
- Pupillary dilation
- pilo erection
- Sweating
- Heart beat
- Strength of heart contract.
- Rate of resp.
- Glycogenolysis (glucose ↑ in blood)
- lipolysis
- proteolysis

Inflammatory response — Basophils

Anti-inflammatory response — Glucocorticoids

Outside (Adrenal cortex)

- Zona reticularis → inner → Sex corticoid
- Zona fasciculata → middle → glucose
- Zona glomerulosa → outer → mineralocorticoid

Corticoids

Glucocorticoid

→ involved in carbohydrate metab.
→ Main glucocort. → Cortisol

- Stimulate:
  - → Gluconeogenesis
  - → lipolysis
  - → proteolysis
  - → inhibit cellular uptake
  - → utilisation of amino acids
- Maintaining ① cardiovasc. ② system Kidney funct.
- Stimulate GFR
- Anti-inflamm. react.
- Suppress immune response
- Stimulate RBC production

mineralocorticoids

→ Regulate balance of water & electrolytes
→ Main mineralocort. → Aldosterone

Acts on renal tubules → Stimulate:

① Reabsorp. of Na^+ & Water
② Excretion of K^+ & phosphate ion

Maintains:

- → Electrolyte
- → body fluid volume
- → osmotic press.
- → Blood press.

Androgenic steroids → by cortex → growth of
- → axial hair
- → pubic hair
- → facial hair

during puberty.

PANCREAS

↓
Composite gland
(acts as both exo & endo - crine gland)

Exocrine
↓
enzymes
↓
Digestion related

endocrine
1 to 2 million islets of langerhans
This is only 1-2% of pancreatic tissue

α-cell
↓
glucagon
↓
"Peptide hormone"
↓
→ Maintains normal blood glucose level
→ Acts on liver cell (hepatocyte)
→ glycogenolysis
→ hyperglycemia
→ gluconeogenesis
→ Reduces the cellular glucose uptake & utilisation
Hyperglycemic hormone.

β-cell
Insulin
↓
"peptide hormone"
↓
→ Regulation of glucose homeostasis.
→ Acts on adipocytes & hepatocyte (in target cell)
→ glycogenesis
→ Hypoglycemia
→ Enhances cellular glucose uptake & utilisation
→ Rapid movement of glucose from blood to hepatocyte & adipocyte.

* Prolonged hyperglycemia
↓
complex disorder
↓
Diabetes Mellitus
↓
- loss of glucose through urine
- form of harmful comp ketone body

Diabetic patient are successfully treated with insulin therapy.

TESTIS
↓
A pair in scrotal sac (outside abdomen)
↓
Perform ducal function

Primary sex organ	Endocrine gland.

Testis
- seminiferous tubules
- stromal or interstitial tissue

* leydig cells / Interstitial cell
↓
present in intertubular space
↓
produce androgen mainly testosterone.
↓
Regulate develop. maturation function. → of male accessory sex organ
↓
- epididymis
- Vas deferens
- Seminal vesicle
- Prostate
- Urethra

- These hormones stimulate
  - → Muscular growth
  - → growth of facial / axillary hair
  - → aggressiveness
  - → low pitch of voice
- Androgens play stimulatory role in
  - → spermatogenesis
  - → act on CNS & influence male sexual behaviour (libido)
  - → Anabolic (synthetic) effect on protein & carbohydrate metabolism

OVARY

A pair of ovaries
↓
in abdomen
↓
Primary female sex organ.

Produce one ovum per menstrual cycle

Estrogen
Synthesized by growing ovarian follicles
- Stimulation of growth & activities of female secondary sex organ
- Develop. of growing ovarian follicles
- appearence of female secondary sex characs. (high pitch voice)
- Mammary gland develop.
- Regulate female sexual behav. (libido)

stromal tissues

After ovulation ruptured follicle changes to C.L → secretes → Progesterone

Progesterone
↓
*Maintenance of pregn.
- Support pregnancy
- Acts on mammary gland
↓
stimulate formation of alveoli (stores milk)
↓
milk secretion.
* Lactation stimulate

HORMONES OF HEART, KIDNEY, GIT

ANF → peptide hormone by atrial wall of our heart → ① reduce BP ② dilation of BV

Erythropoetin → peptide hormone by juxtaglom. cells of kidney → stimulates erythropoesis

These hormones regulate the secretion of digestive juices & help in digestion.

Endocrine cells in diff. parts of GIT
↓
4 peptide hormone

- **Gastrin** → Acts on gastric glands. → Stimulates secretion of HCl & pepsinogen
- **Secretin** → Acts on exocrine pancreas → Stimulates "secr" of water & bicarbonate ions
- **Cholecystokinin (CCK)** → Acts on both gallbladder & panc. → gallbladder: Stimulate "secr" of bile juice; panc.: Stimulate "secr" of pancreatic enzyme.
- **GIP (Gastric Inhibit peptide)** → Inhibits gastric secretion & motility

* Several other non-endocrine tissues secrete hormones called growth factors. These factors are essential for normal growth of tissues & their repairing / regeneration.

MECH. OF HORMONE ACTION

Date / /
Page

- Hormones produce their effect on target tissue by binding to specific protein called **hormone receptor.**
  - located in target tissues only
    - Membrane bound recept.
      - On the cell membs. of target cell
    - * intracellular recept.
      - Inside target cell.
      - * Mostly nuclear receptor (inside nucleus)

* Hormone + Receptor → hormone-receptor complex.

☆ Each receptor is specific to one hormone only & hence ~~receptor as specific to one hormone only~~ & hence receptors is specific.

Leads to certain biochemic al changes in target tissue.

Target tissue metabolism hence physiological function are regulated by hormones

On the basis of chemical nature →

i) Peptide, polypeptide, protein

- insulin
- Glucagon
- Pit. hormones
- hypothalamic hormones
- TCT
- ANF
- PTH
- Thymosin

ii) Steroids

- cortisol
- testesterone
- estradiol
- progesterone
- Aldosterone

- Sex corticoid
- Mineral corticoid

(All corticoids)

iii) Iodothyronines

- Thyroid hormones.

iv) Amino acid derivatives

- epinephrine ; nor epinephrine

Hormones which interact with membrane bound receptor

↓

Do not enter target cell

↓

~~Generate second messenger~~

↓

cyclic AMP, IP_3, Ca^{2+}

↓

Regulate cellular metab.

→ PROTEIN HORMONES
→ Amino acid derivative

Hormones which interact with intracellular receptor

↓

Regulate gene expression
or
Chromosome funct. by interact. of hormone receptor complex with genome

↓

Cumulative biochemical actions result in physiolog. & developm. effects.

→ steroid
→ iodothyronines